Investigation of RHIC pp Transverse Emittance Growth

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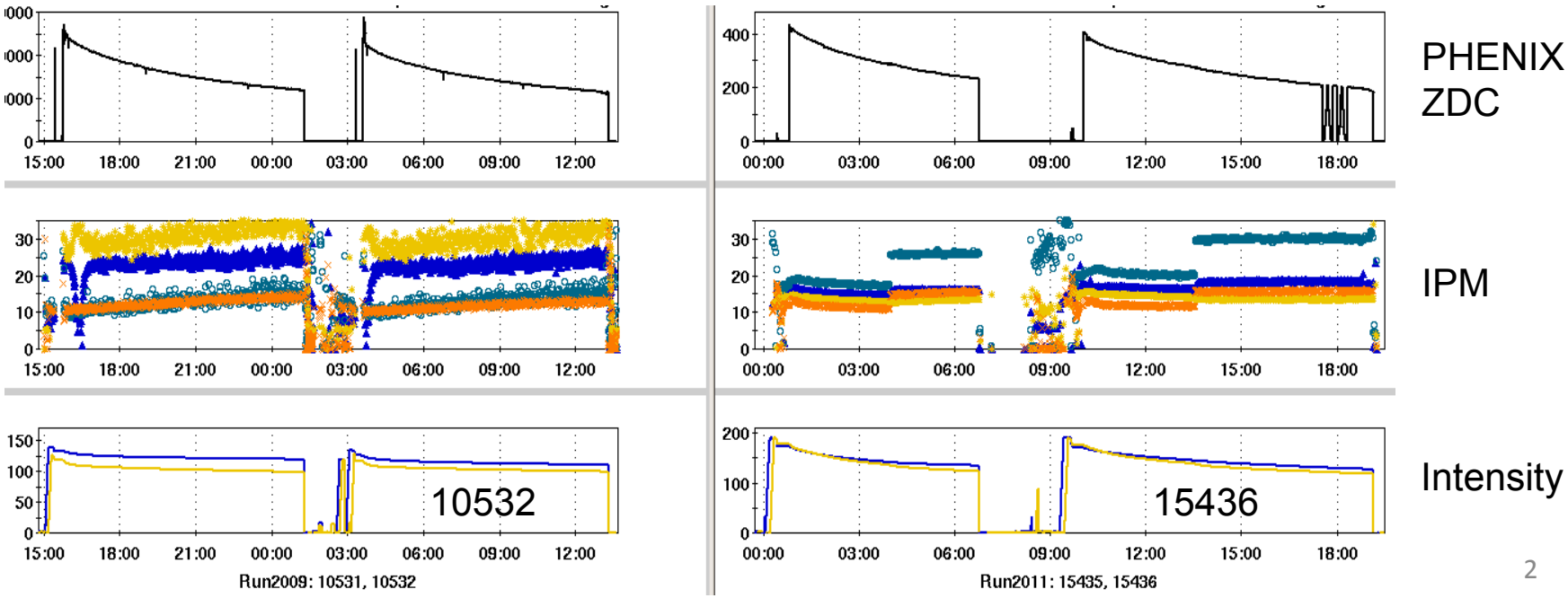
- **In proton 100 GeV Run5, 6, 8, 9 and 250 GeV Run9, the transverse emittance growth is related to the beam-beam parameter ξ. Typically for ξ =0.011, emittance growth is 5%/hour, and the luminosity lifetime is 15 hours. Beam-beam effect is mainly presented by the emittance growth.**
- **Run11 has no transverse emittance growth in store, but the luminosity lifetime is unchanged for given ξ. Beam-beam effect is all presented by the beam-loss.**
- **Many factors can be ruled out, including bunch intensity, bunch length and peak current, RF voltage, dp/p, working point, etc. In fact, so far no synchrotron and/or betatron dynamics is found responsible.**
- **IPM shows possible flat transverse emittance for both Blue and Yellow, horizontal and vertical. It looks like emittance collimation, but how?**

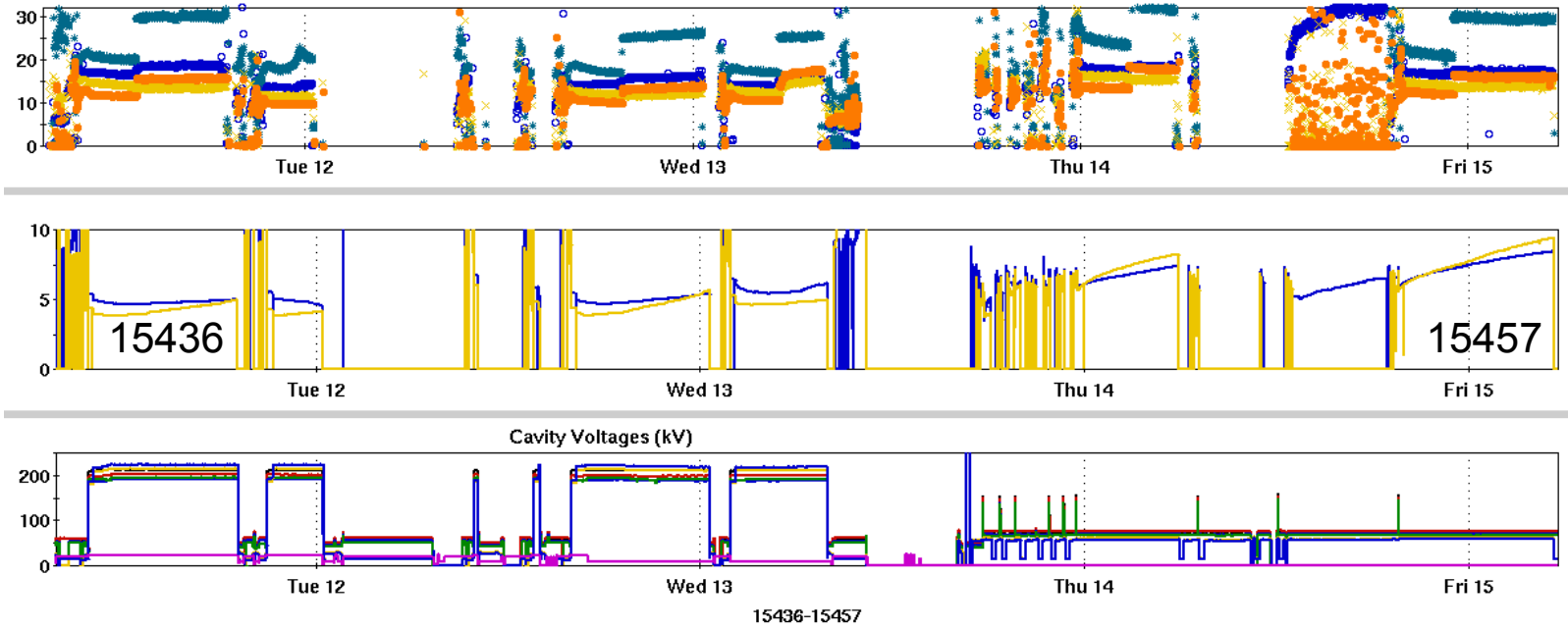
- **In all previous proton runs (> 400 long fills), not a single fill had transverse emittance growth below 4%/hour at ξ =0.011.**
- **In Run11, the emittance has no growth up to ξ =0.0138.**
- **10532 in Run9 and 15436 in Run11. Beam-beam parameter is taken at 1.5 hour after accramp. Other parameters' time evolution is the average of next 4 hours.**

Fill	Run	Beam-beam parameter	Emittance growth, %/h	Intensity lifetime, hour	Luminosity lifetime, hour
10532	2009	0.0103	6.1	107	15.5
15436	2011	0.0119	0.2	26.8	14.2



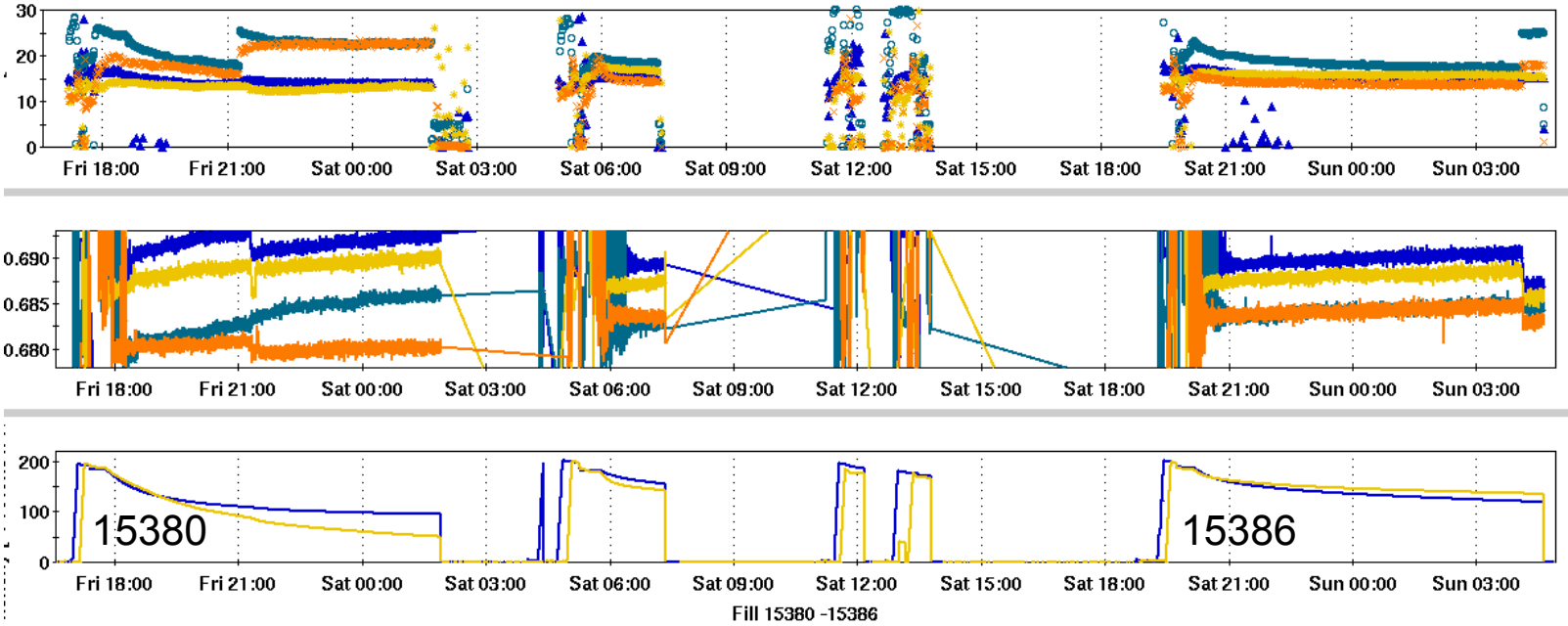
- **15436 (9 MHz) and 15457 (28 MHz). The IPM looks identical, but the RF is different.**
- **Factors not affecting the emittance growth include most synchrotron dynamics?**
- **For observed bunch length of 12 ns, dp/p of 15436 is 0.00063, and 15457 is 0.00038, 40% lower. So dp/p is not relevant.**

Fill	9 MHz kV	28 MHz kV	197 MHz kV	Peak current A	Momentum spread
15436	22	400	220	4	0.00063
15457	0	150	60	3	0.00038

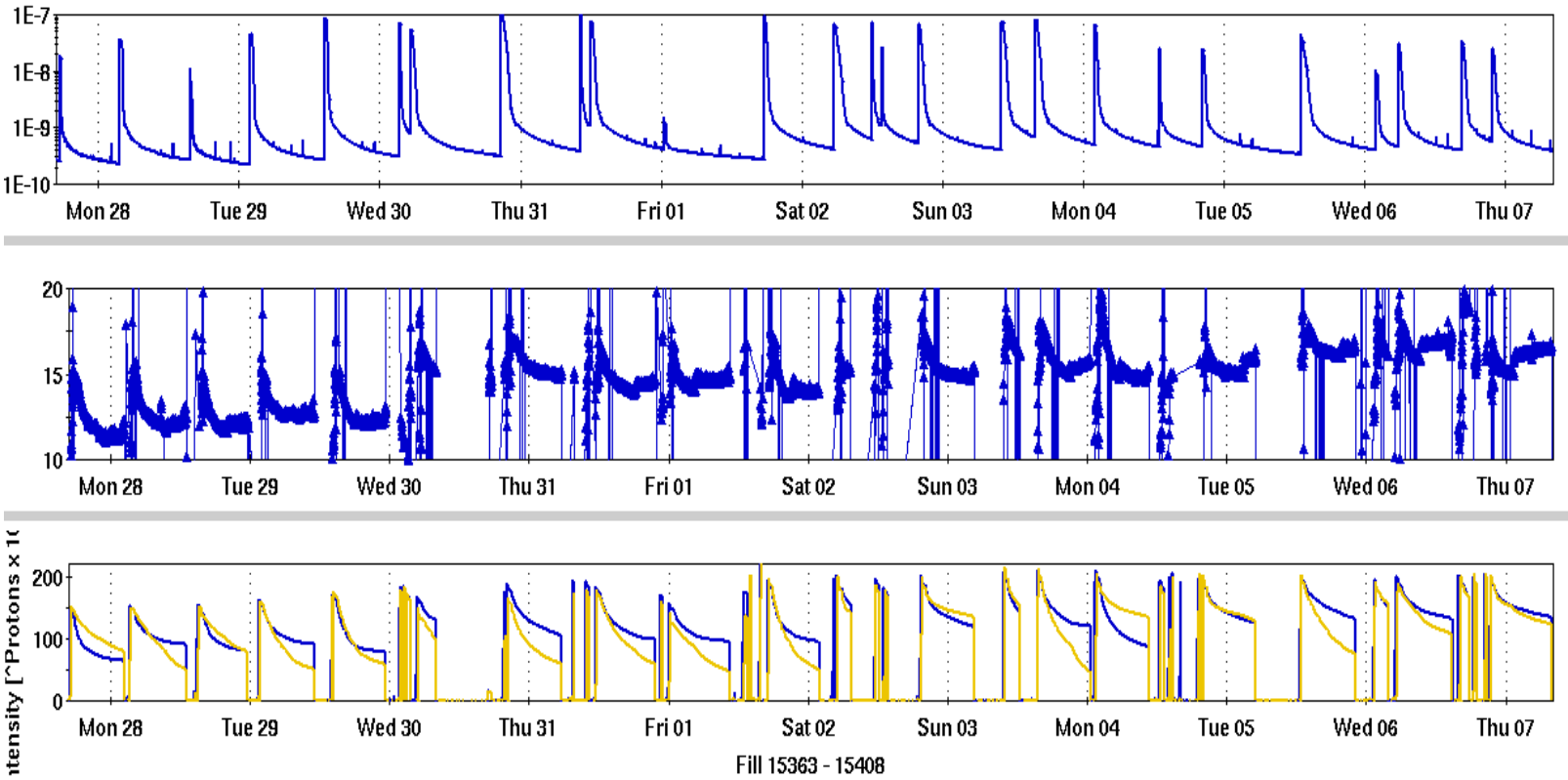


- **B&Y fractional vertical tune of 15380 is 0.680, and 15386 is 0.684. 15386 intensity lifetime is more than doubled. Emittance looks similar.**
- **No effect on working point + dp/p implies dynamic aperture is irrelevant?**
- **No effect when AnDY turned on, with 50% larger beam-beam.**
- **Compared with Run9 (pp93), in Run11 (pp11v10) IP2 β* is reduced from 7.5 m to 3 m, but in Run5, IP2 β* was 3 m.**

Fill	Blue vertical	Yellow vertical	Emittance growth, %/h	Intensity lifetime, hour	Luminosity lifetime, hour
15380	0.380	0.380	-0.7	10.4	6.6
15386	0.384	0.384	-0.5	29.0	16.6



- **Falling BH IPM emittance is due to the falling BH IPM pressure. Similarly for BV, YV, and YH. Emittance reduction is an artifact.**
- **For rest of store, larger emittance seems related with higher pressure.**
- **Real emittance in Blue and Yellow, horizontal and vertical, might be somewhat flat?**
- **No emittance growth in H/V might be explained by coupling. No emittance growth in B/Y indicates IRs should be focused on, or some device applied to both beams.**



Summary and discussion

- In Run11, the beam-beam effect is not shown as the transverse emittance growth (B&Y, H&V), but as the beam loss.
- Many factors can be excluded, and so far no synchrotron and/or betatron dynamics can be found relevant.
- A possible emittance collimation may explain as the follows: beam-beam induces emittance growth, but the emittance is limited, which causes beam loss.
- Understanding is useful for the E-lens commissioning. It would be interesting to see how the 100 GeV and 250 GeV proton Run12 behave. If the same, then the problem will be located.
- In Run10, YH IPM moved from Yi2 to Yo1, and BH IPM moved from Bi1 to Bo2, both with larger beta functions. Better calibration of the IPM might help.